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CHEMICAL ACTIVITIES AND THE UNDERSTANDING OF REAL-WORLD PHENOMENA.

PRACTICAS EN UN CURSO DE QUIMICA Y COMPRENSION DE FENOMENOS COTIDIANOS

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Abstract

One of the goals in a Chemistry course is to make students able to think in terms of Chemical reactions when they observe real -world phenomena. The experience in teaching General Chemistry at University have me notice that most of the students, even in their first years at University do not know which elements or compounds are mainly represented in everyday substances. My proposal is to make some projects in addition to a "classical" laboratory program. These projects would be attempted to connect on the chemical facts and principles introduced in the lectures, with some familiar aspects of our surroundings on earth could be helpful. At the beginning of the course students are given a text in which they can show their knowledge and the activities which are worth while to do. Then, students are divided in small groups. They are explained the aim of their project and have to look for information. After having analysed the information with the teacher the experiment is carried out. Photographs are taken during the experiment and slides prepared. This material is used when the group of students explains the activity to the rest of the class. Here are shown the first experiences in a General Chemistry classroom order to evaluate the possible effect in the

teaching process.

Keywords: Laboratory, Curriculum, Chemistry

Resumen

Uno de los objetivos en un curso de qu’mica es conseguir que los alumnos sean capaces de pensar en términos de reaccines quimicas cuando observan fen—menos de la vida cotidiana. Algunas veces, los estudiantes, incluso en la universidad, no saben reconocer los elementos o compuestos que forman sustancias cotidianas. La propuesta es hacer realizar algunas actividades con el objetivo de poner en contacto reacciones qu’micas cotidianas y conceptos introducidos en las clases con observaciones de la vida cotidiana. Se divide a los alumnos en peque–os grupos. Se les explica el obetivo del experimento y se les pide que busquen informaci—n relativa a la práctica. Después de comentar los datos obtenidos por los alumnos se realiza el experimento. Se toman fotografias durante la realizaci—n de la actividad y cada grupo expone al resto de la clase la experiencia realizada.

Keywords: Laboratorio, Plan de estudio, Qu’mica

Introduction

Selecting a laboratory program for a General Chemistry course is not an easy task. Of course the program should illustrate the subjects in the chemical curriculum, but students should also be guided in understanding real world phenomena as well as the nature of everyday substances. One of the goals in a Chemistry course is to make students able to think in terms of Chemical reactions when they take bicarbonate for stomach ache, use a pressure cooker, a cleaner or in the case they heard about acid rain. Bodner found that students do not extend their knowledge beyond the limits of the classroom into the real world (Bodner, 1991).

Gabel et al. (Gabel and Samuel, 1987) carried out some studies which dealt with university students studying to be elementary school teachers and found that their conceptions of the particular

nature of matter were below the desirable level.

We have noticed that most of the students, even in their first years at University do not know which elements or compounds are mainly represented in vinegar, marble, sea sand, etc.

Possible solutions to the problem could be:

a- Some specific lectures to introduce several chemical topics.

b- Give this information during the course at the moment we think it is more

appropriate. That is what we normally do in the Department, but it seems no to be effective.

c- Some new activities or a modification of the laboratory program.

I think the third option may be the best one. The question is if these activities should be

carried out in a different way in order to get better results. The student should have

successful experiences and enjoy chemistry.

Nava Ben-Zvi and Riuka Gai (Ben- Zvi and Riuka, 1994) write about the genuine difficulty y translating "classroom knowledge into the comprehension of real life phenomena". In their work they study the relationship between the understanding of the nature of matter and the ability of the students to analyse real world phenomena (on both the macro and micro level). An adequate laboratory program attempted to connect the chemical facts and principles introduced in the lectures with some familiar aspects of our surroundings on Earth .

Methodology

Our actual laboratory program for students in the General Chemistry course consist on several activities which illustrate some of the classroom subjects. These are some of the topics:

1- Introductory work (solution preparations, solutions transference, learning technics as filtration...).

2- Electrolytes reactions.

3- Redox reactions.

4- Titration. Neutralisation and redox

titration.

5 - The kinetic study of a reaction.

6- Synthesis of CO_2.

7- Introduction to organic reactions.

8- An easy organic synthesis. Preparation of salicylic acid.

Although the experiments are intended to contain some aspects to address our objectives, it would be necessary to introduce new activities. Unfortunately there is no possibility to extend the laboratory program. Thus, the proposal is to make some projects in addition to the

current program.

At the beginning of the course the students are divided into small groups. We start with a text in which the students could show their knowledge and the

activities which are worth while to do. In the first reunion of each group with the

teacher, students are explained the aim of their project and asked for some information

needed. The second reunion takes place in order to analyze the information the students

have collected and explain possible doubts. In the following meeting (in the laboratory)

the experiment is carried out. Photographs are taken during the experiment and slides

prepared. This material is used when the group of students explain the activity to the rest of the class. Before preparing the projects to do in the new course we wanted some information about the possible effect this system could have on the learning process. I asked for voluntary students in my classroom and had no problem to form some groups. Two easy and funny experiments were selected (Borgford and Summerlin 1988) to do: the detection of nitrogen in hair and the synthesis of artist`s paints.

Experiments

Detecting nitrogen in hair:

Students got a sample of the hair belonging to a child (no colorant or artificial product). They were explained that hair consist primarily of a protein called keratin. This protein is also contained in skin, for example. Proteins are polymers consisting of amino acids and all amino acids contain the element nitrogen.

Certain factors and substances, as hot, acids, bases or alcohols can denature proteins. In the first step hydrogen bonds of the helix formed by the aminoacids in the protein are broken. When the protein is denatured completely, nitrogen is released as ammonia.

PROTEIN ----------> AMINOACID ----------> AMMONIA

(Polymer) $R\text{-}CH_2\text{-}(NH_2)\text{-}COOH$ NH_3

Students were asked about exothermic reactions and possible basic media to be used as conditions in the second part of the experience. They selected the possible acids and indicators to use in the titration process.

The first part of the activity consisted in a qualitative experiment. The treatment of about an inch of hair with a gram of CaO.

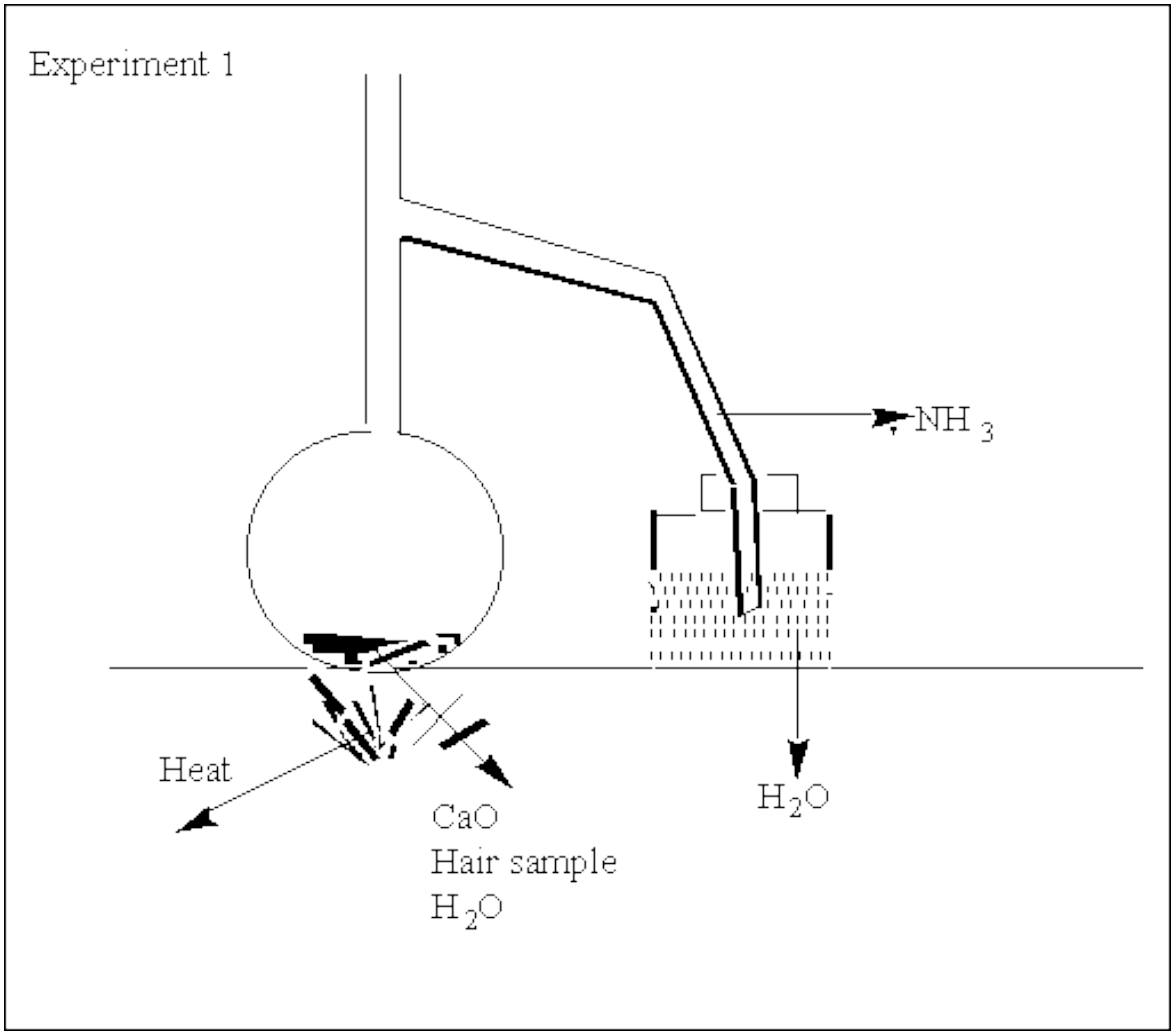
- The mixture is covered with water and heated.

- The smell of ammonia is noticed (not only ammonia, as also sulphur is contained in keratin).

-A litmus paper is hold over the mouth of the test tube and the colour noticed the basic nature of the gas.

In the second part we tried to do a quantitative experiment.

-A sample of hair (5.2 g) is treated with a concentrated solution of NaOH and heated in a flask as shows figure 1.


Experiment 1
NH 3
Heat
CaO
Hair sample
H2O
H2O

-The ammonia gas is collected in an erlenmeyer which contains 120 ml of H_2O.

-The evolution of ammonia is noticed by the burble of the gas in the water. The reaction is stopped when the hair has become a brownish gelatine.

-The ammonia is titrated with HCl 0.1 M using phenolphthalein as indicator.

$$HCl + NH_3\,H_2O \text{ ----------> } NH_4Cl + H_2O$$

This way students can calculate the percentage of N in hair.

Making artist`s paints

Casein is a phosphoproteide found in milk (3%) it represents the 80% of the proteins in milk. It is a white substance, not soluble in water but soluble in basic media. Among their applications we can find:

a- Cheese making

b- Pressed casein treated with formaldehyde gets a hard appearance and forms a hard plastic which is used to make buttons

c- Artist«s paint making

d- It is used in the paper industry.

The experience was carried out the way:

1- Obtention of casein from milk. It is an easy experiment. The addition to milk of acid media to pH 4.7 affords the precipitation of the white solid which is filtered off and dried.

Students were told that paints could be obtained by mixing casein with a pigment of the desired colour and an small amount of water.

2. Make the pigments.

This synthesis consist in the selection of a water reaction which afford a coloured solid substance which is filtered off and washed. For example, the reaction of a solution of 0.3 g of potassium hexacyanoferrate(II) in water (4ml) with 0.2 g of cobalt chloride affords a solid: Co2Fe(CN)6, cobalt hexacyanoferrate(II), a gray-green pigment (students shoud be advised that cobalt chloride is toxic).

$2\ Co^{2+} + [Fe(CN)_6]^{3-}$ ----------> $[Co_2Fe(CN)_6]$ (gray-green)

2b- Make the paints.

To a small amount of casein (enough to cover a penny) is added water until a thick paste is made. The same amount of the desired pigment is added.

The students were given some other reactions for the formation of different pigments and were encouraged to look for some others.

Ca^{2+} + CO_3^{2-} ----------> $[CaCO_3]$ (white)

(0.3 g $CaCl_2$) (0.3 g Na_2CO_3)

Co^{2+} + SiO_3^{2-} ----------> $[CoSiO_3]$ (royal blue)

(0.2 g $CoCl_2$) (1 ml Na_2SiO_3 saturated solution)

This activities were explained in class to the rest of the students

Conclusions

After this experience we have arrived at the following findings:

- It was easy to find students groups for the experiments. They enjoyed the experiment and thought there was a funny way of learning. Their were interested in such a sort of projects. This means that during this experiences the teacher has catch the attention of the students which necesarry in the process of teaching and learning.

- They began to make questions about similar aspects of other substances (nails also contains proteins). It was one of the objectives, to make the student able to think in terms of what is explained and to understand real life phenomena.

- It is an opportunity for students to improve their expressions and to learn to put ideas into words. As they have to explain the activity in class, it is necessary for them to understand it properly and to know how to express themselves. On the other hand, they have to get used to look in the literature.

- It is also very important for the teacher who can analyze the problems that students have with the

language or subjects studied.

- As the projects are done by small groups of students and twice a month there was no problem of laboratory time . It took part of a theory class to explain each experiment by the students but it can be done twice a moth and I think this time is worth while.

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